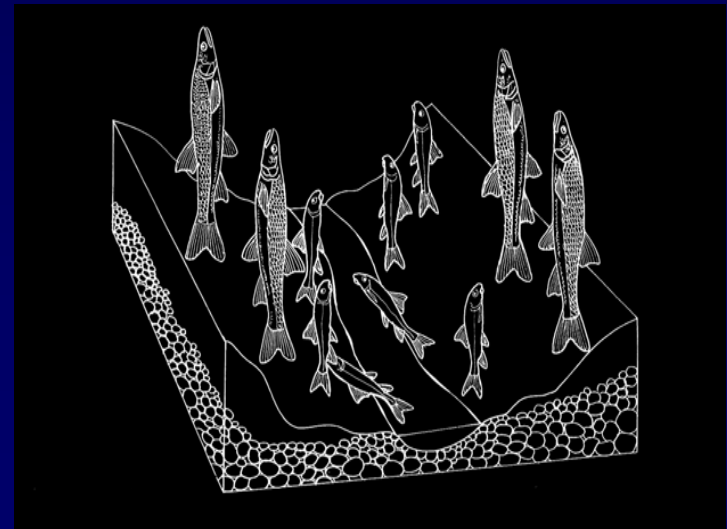


Vegetation Models to Inform Streamflow Alteration Decisions

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Why care
General issues
Taxonomy of tools
Doing a better job

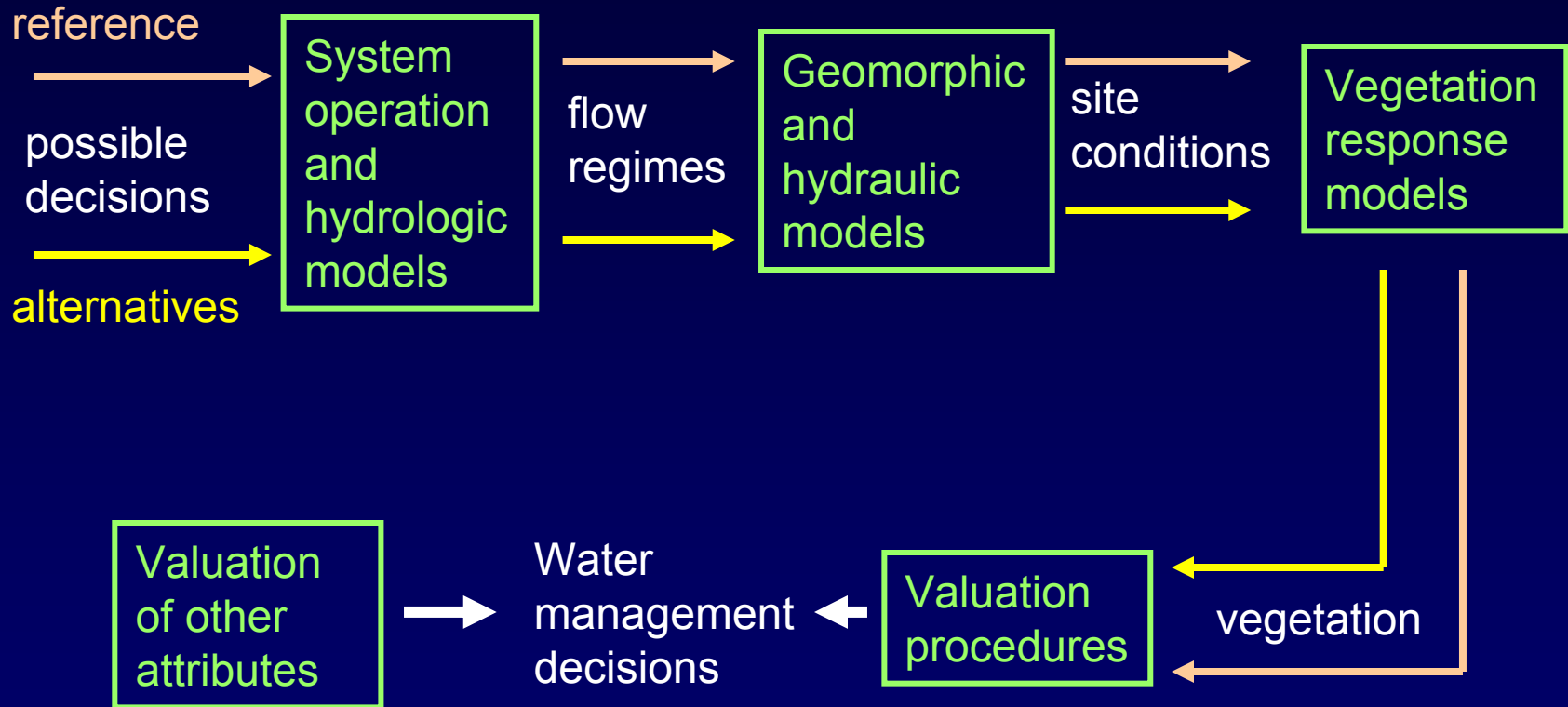


Why Care

- Aquatic habitat
 - flood-pulse, shallow-slow, LWD
- Wildlife habitat
 - unique structure and juxtaposition
- Aesthetics
- Plant communities and species
- Variable in physical models
 - hydraulic roughness, sediment transport, evapotranspiration



Streamflow-Vegetation Models in Water Management Decisionmaking



Streamflow-Vegetation Models

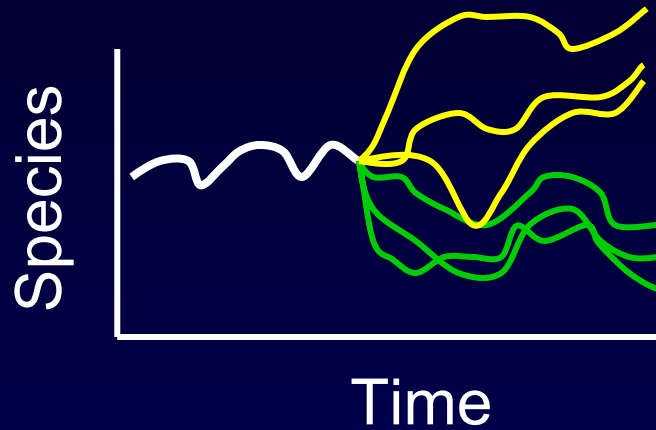
① Dynamic simulation – iterative application of rules for change

- ODE, difference equations, transition matrices, sets of if-then rules
- Individual-based forest stand models
- Lumped-parameter, compartmental models
- Assembly rules, environmental filtering of species pool
- Rules dependent on streamflow
- Output -- vegetation trajectory predicted from a streamflow sequence, *families of trajectories from probabilistic responses to families of streamflow sequences*

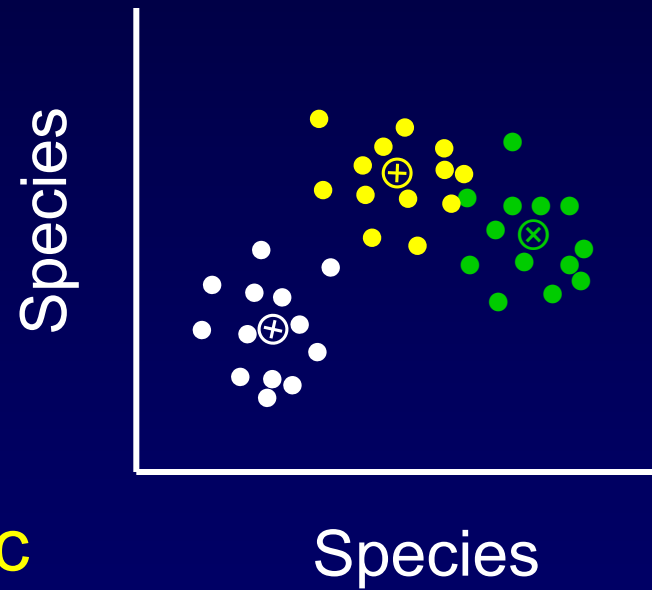
Streamflow-Vegetation Models

② Static – quasi-equilibrium

- Time-aggregated environmental conditions (input)
- Classification and gradient models
- Environmental regime includes streamflow dependent variables (inundation, flooding, depth to groundwater)
- Output -- width and length of riparian zone, species composition, *really time clusters of conditions associated with different regimes*



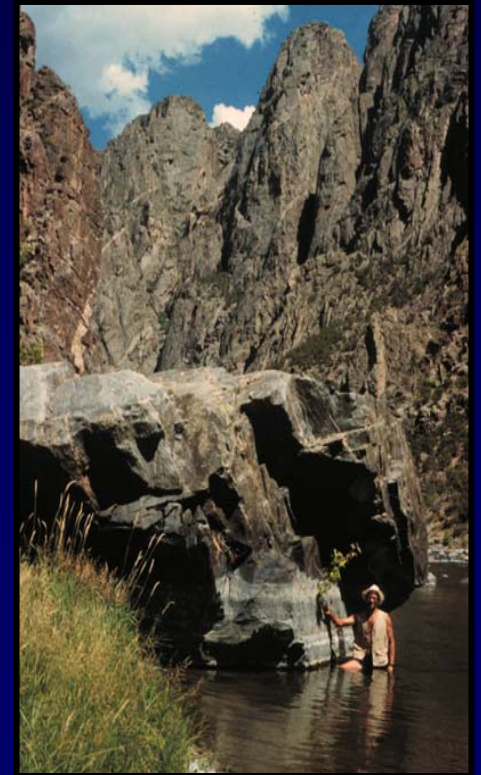
Dynamic



Static

Static - Hydroperiod Gradient

- Flow regime as flow duration curve
- Hydraulic model to determine inundating discharge of bottomland plots
- Vegetation distribution on gradient of inundation duration
- New flow regime → new inundation durations → new vegetation at plots



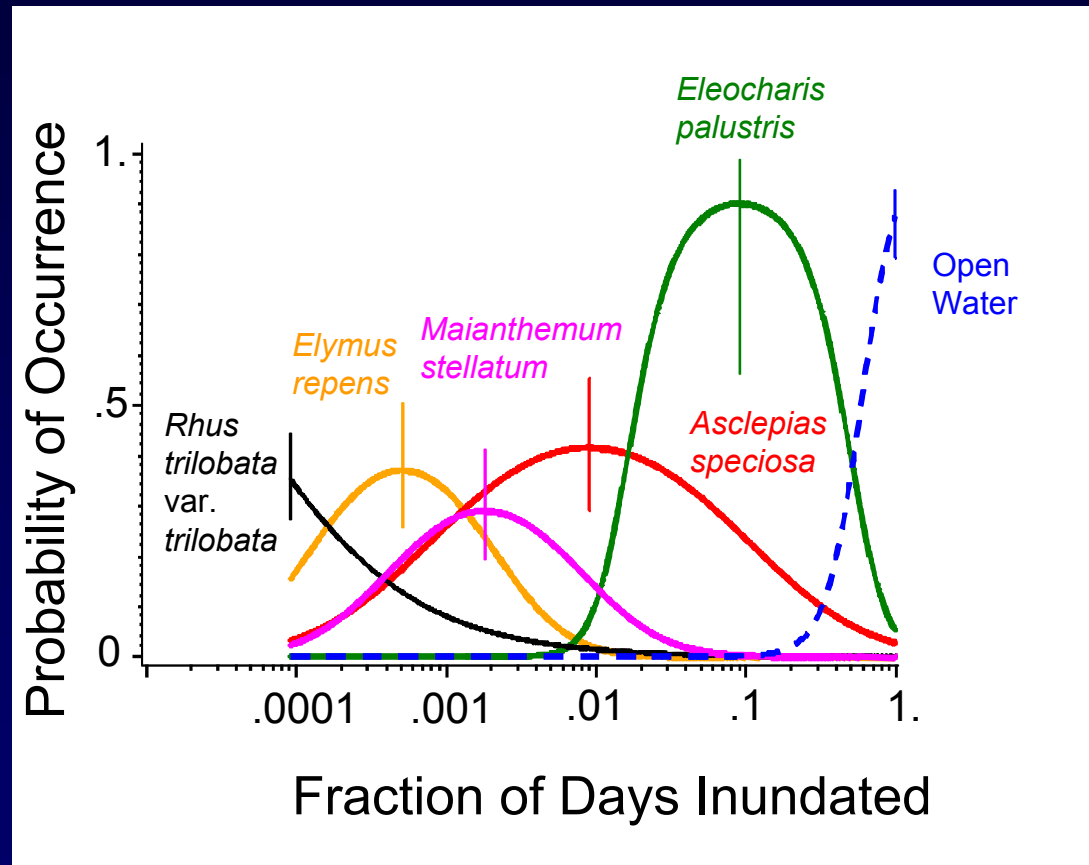


Fremont River, UT

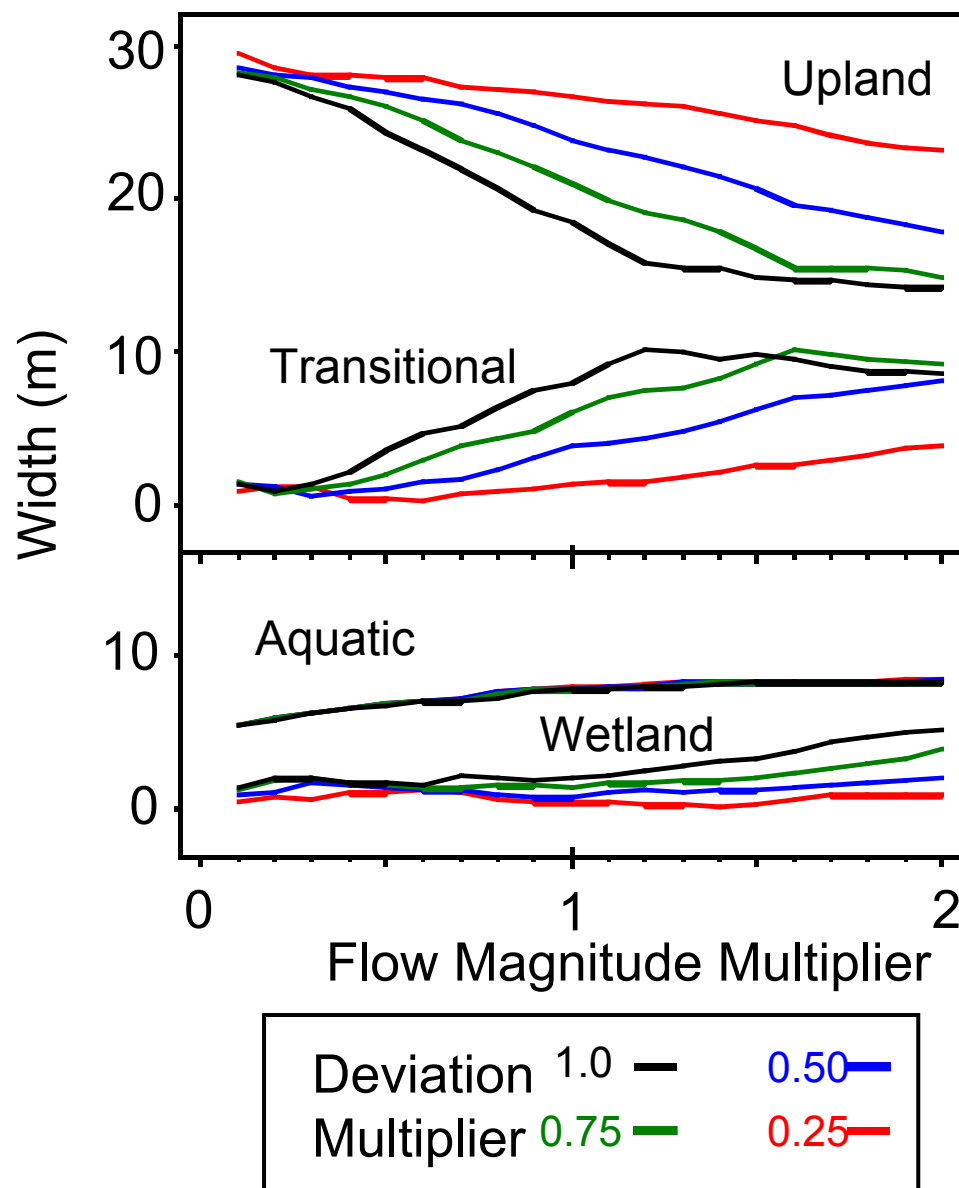
- Nominal 19-yr daily flow regime
- 23 cross sections on 265 m reach
- HEC-RAS hydraulic model
- Presence-absence in 361 plots

Species on Hydroperiod Gradient

- Logistic regression for 39 spp
- 94% of spp-plot occurrences
- New flow duration gives new plant distributions on plots



- Systematic variation in flow regime
- Estimate wetland delineation prevalence index for plots by species occurrence probabilities
- Aggregate plots and cross-sections to average widths



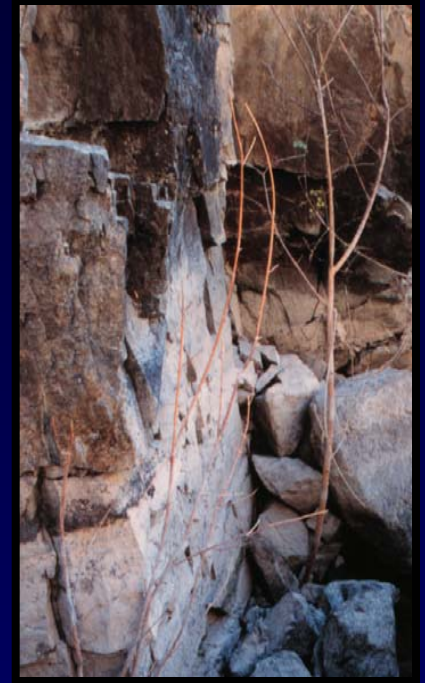
Streamflow-Vegetation Models

③ Suitability scoring

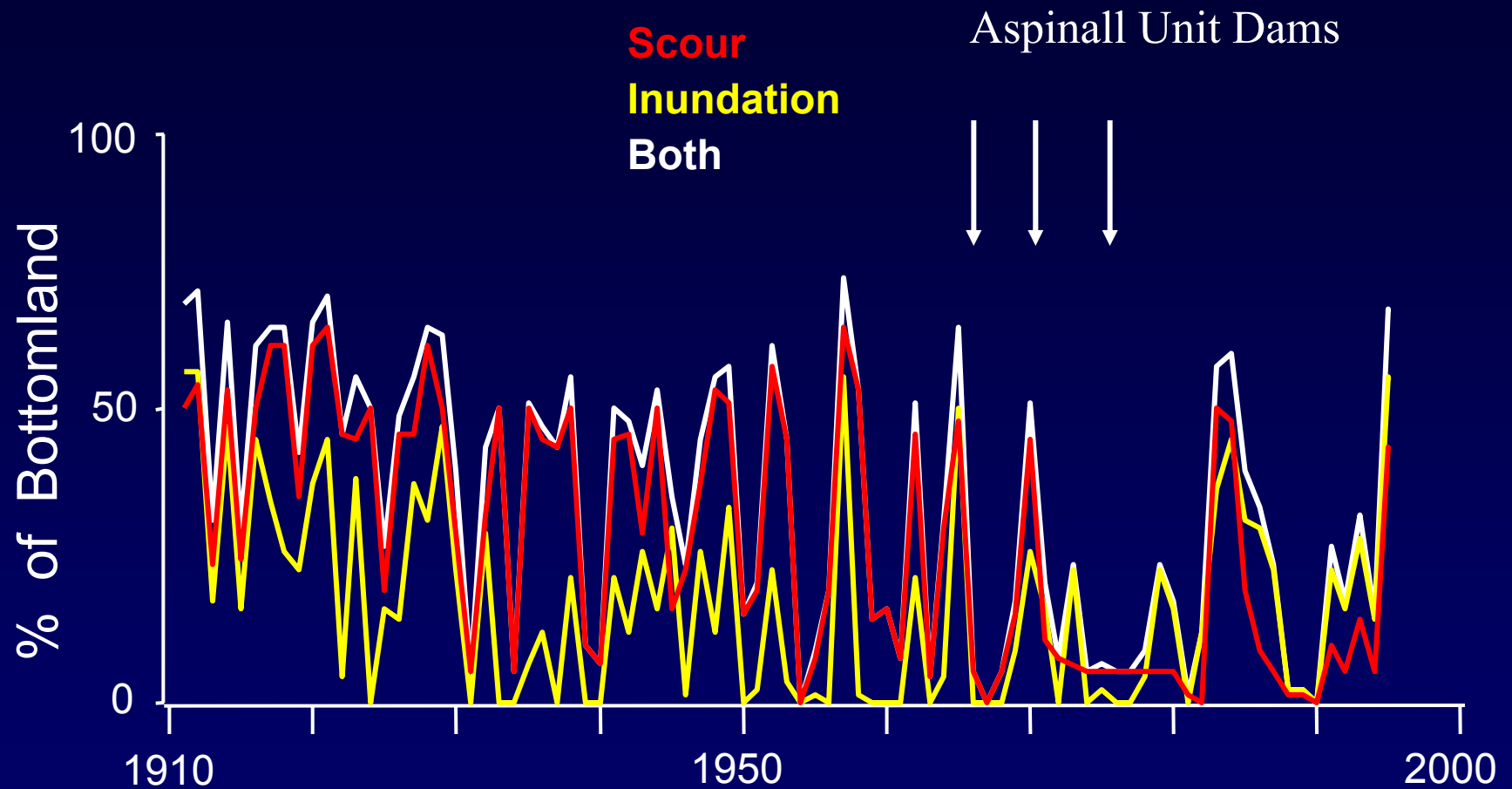
- Individual value or sequence
- Not updating state
- Tolerance ranges – inundation, depth to groundwater, scour
- Life-history requisites – regeneration niche
- **Output -- suitability, fraction of time condition is met**

Scoring - Streamward Extent of Vegetation

- Black Canyon of Gunnison, CO
- Hydraulic model
- Score each year by fraction of bottomland cleared of trees (*Acer negundo*)
- 2-factor, binary mortality function
 - extended inundation (>85 days) from 94-95 survival
 - shear > critical from worst (dendrochronology) survived



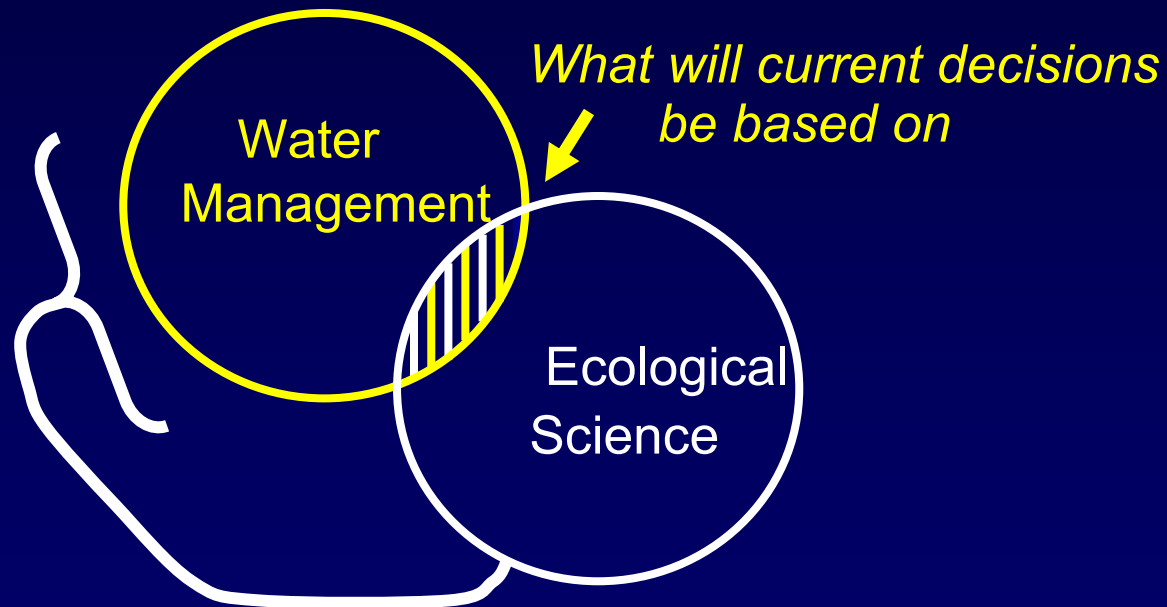
Estimated Clearing by Year



Doing a Better Job

❖ Scoping-problem definition

- Input, output, scale: *relevant, accurate, consistent*



Doing a Better Job

- Measurement advances
 - Isotopic water signatures
 - Higher dimensioned hydraulics
 - Genetic analysis
 - Topographic (LIDAR) data acquisition
 - Remote sensing-GIS

Doing a Better Job

- Conceptual
 - Beyond interdisciplinary exchange \Rightarrow joint problem definition
 - Beyond longitudinal and transverse gradients \Rightarrow chains of repeated meso-scale landscape structures
 - Scaling: when does $\frac{1}{2}$ of water give you more or less than $\frac{1}{2}$ of river ecosystem?

Paradigm Pressures of Plant Ecology on River Flow Analysis

- Probabilistic response trajectories
- Long-time scales
 - transient responses of decades to centuries
- Importance of channel change, sediment transport, and extreme events
- Multi-species assemblages
- Effects of organisms on physical environment